| **Obuda University**<br>John von Neumann Faculty of Informatics | *Institute of Applied Mathematics* |
|---|---|

**Name and code:** **Credits:3**

*Differential equations* NMXDE1PMNE

*2021/22 year I. semester*

Subject lecturers: Dr. Zoltán Léka

| Prerequisites (with code): | - | | | |
|---|---|---|---|---|
| Weekly hours: | Lecture: 2 | Seminar.: 1 | Lab. hours: 0 | Consultation: 0 |
| Way of assessment: | Two midterm exams + written exam | | | |

**Course description:**

*Goal*: To provide an overview of the fundamental concepts of planar dynamical systems. Moreover, the course discuss the methods of calculus of variations with applications in mechanics, and elements of PDEs (heat and wave equations in Euclidean spaces)

*Course description:* Dynamics of first and second order differential equations, stability of fixed points through linearization. Energy methods and Lyapunov direct methods. Periodic solutions, limit cycles. Calculus of variations. Hamiltonian and Lagrangian systems, Legendre transform. Elements of PDEs: method of characteristics, heat equation, wave equation.

**Lecture schedule**

| *Education week* | *Topic* |
|---|---|
| 1. | First-order ordinary differential equations: linear, exact and separable systems |
| 2. | Dynamics of first order autonomous differential equations, fixed points. |
| 3. | Dynamics of second order systems: Jacobian matrix, characterization of fixed points through linearization, stability |
| 4. | Energy methods, Lyapunov s theorems on stability |
| 5. | Periodic solutions, limit cycles: divergence criterion, Poincaré-Bendixson theorem |
| 6. | 1st written exam |
| 7. | Introduction to variational calculus: brachistochrone problem, Euler-Lagrange equations |
| 8. | Calculus of variations in mechanics, Hamiltonian systems |
| 9. | Hamiltonian and Lagrangian systems, Legendre transformation |
| 10. | Partial differential equations: method of characteristics |
| 11. | Second order partial differential equations, classification |
| 12. | Laplace operator, Dirichlet energy and the heat equation |
| 13. | 2nd written exam |
| 14. | Goursat- and Cauchy problems, the wave equation. |

**Midterm requirements**

| *Education week* | *Topic* |
|---|---|
| | Weekly home assignments in each actual topic |

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**Final grade calculation methods**

| Achieved result | Grade |
|---|---|
| 89%-100% | excellent (5) |
| 76%-88<% | good (4) |
| 63%-75<% | satisfactory (3) |
| 51%-62<% | passed (2) |
| 0%-50<% | failed (1) |

**Type of exam**

Written exam

**Type of replacement**

One written exam of the semester can be replaced at the final week

**References**

Mandatory:

R. Kent Nagle, Edward B. Saff, Arthur David Snider: Foundamentals of Differential Equations and Boundary Value Problems, 8th Edition, Addison-Wesley, 2011.

D. Strogatz: Non-linear dynamics and chaos, Westview Press, 2001.

Recommended:

E. Lieb, M. Loss: Analysis, Amer. Math. Soc., Providence, 2001.

Simon J. Malham: An introduction to Lagrangian and Hamiltonian mechanics, 2016.

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